

Statistics

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Kenneth J. Koehler, Interim Chair of Department

Distinguished Professors: Athreya, Meeker

University Professors: Koehler, Lorenz, Stephenson

Professors: Amemiya, Bailey, Bonett, Brendel, Carriquiry, Dixon, Isaacson, Kennedy, Lahiri, Morris, Shelley, Vardeman, Wolter

Professors (Collaborators): Therneau

Distinguished Professors (Emeritus): Herbert A. David, Fuller

University Professors (Emeritus): D. Cox, Herbert T. David, Groeneveld, Hinz

Professors (Emeritus): C.P. Cox, Harville, Hickman, Hotchkiss, Pollak, Strahan, Wolins

Associate Professors: Cook, Kaiser, Marasinghe, Nettleton, Nusser, Opsomer, Roberts, Rollins, Sherman, Yang

Associate Professors (Emeritus): Sukhatme

Assistant Professors: Adams, Dorman, Duckworth, Evans, Froelich, Hofmann, Huang, Maiti, Wu

Assistant Professors (Collaborators): Sargent, Sloan

Undergraduate Study

For the undergraduate curriculum in liberal arts and sciences, major in statistics, leading to the degree bachelor of science, see *Liberal Arts and Sciences, Curriculum*.

The curriculum in liberal arts and sciences with a major in statistics is designed to prepare students for (1) entry level statistics positions requiring the B.S. degree in statistics in business, industry or commerce, nonprofit institutions, and in state or federal government; (2) graduate study in statistics. Entry-level positions include the following types of work: statistical design, analysis and interpretation of experiments and surveys; data processing and analysis using modern computation facilities and statistical computing systems; application of statistical principles and methods in commercial areas such as finance, insurance, industrial research, marketing, manufacturing, and quality control. Nonprofit organizations such as large health study institutions have entry-level positions for B.S. graduates in statistics. Also, there are opportunities for work in statistics that require a major in a subject-matter field and a minor in statistics.

Students completing the undergraduate degree in statistics should have a broad understanding of the discipline of statistics. They should have a clear

comprehension of the theoretical basis of statistical reasoning and should be proficient in the use of modern statistical methods and computing. Such graduates should have an ability to apply and convey statistical concepts and knowledge in oral and written form. They should be aware of ethical issues associated with polling and surveys and in the summarization of the outcomes of statistical studies.

Undergraduate majors in this department usually include in their programs: (a) Statistics 101 or an alternative introductory course (104 or 226), (b) Mathematics 165, 166, 265 (or 165H, 166H, 265H), 307 (or 317) and Computer Science 207, and (c) Statistics 341, 342, 401, 402, 421, 479, 480.

These courses plus at least two additional courses in statistics at the 400 level or above constitute the major. With the permission of the department, I E/Stat 361 may be substituted for one of these 400 level courses. It is advisable to have a minor in a field of application.

The department offers a minor in statistics which may be earned by completing an introductory course in statistics plus additional courses from 341, 342, 361, and 400 level or above to yield a total of at least 15 credits in statistics courses.

English and Speech proficiency requirement: The department requires a grade of C- or better in each of Engl 104 and 105 (or 105H), and completion of one of Engl 302 or 314 with a grade of C- or better. The department requires a passing grade in ComSt 102 or Sp Cm 212.

Students intending to do graduate work in statistics normally will take additional courses in mathematics.

Graduate Study

The department offers the degrees master of science and doctor of philosophy with a major in statistics, and minor work for students majoring in other departments. Within the statistics major the student choose to emphasize topics such as experimental design, probability, statistical methods, statistical theory, statistical computing, survey sampling, quality control, spatial statistics, time series, reliability, or applied statistics (e.g., [biometrics](#), econometrics, environmental statistics, psychometrics, sociometrics, etc.). A major in operations research leading to a master of science degree is offered in cooperation with the Department of Industrial and Manufacturing Systems Engineering. The doctor of philosophy degree is offered as a co-major with other departments. Such departments have included Animal Science, [Botany](#), Economics, Educational Leadership and Policy Studies, [Genetics](#), Industrial and Manufacturing Systems Engineering, Mathematics, Meteorol-

ogy, and Psychology.

M.S. graduates have a basic understanding of statistical theory and methods. Elective courses in statistics provide the opportunity for the student to emphasize particular areas within the field of statistics, based on interest and future career goals. Communication skills are developed through course projects, assistantship duties and creative components. Ph.D. graduates study advanced theory and methods and are able to do independent research in statistics and collaborative research outside of statistics.

Prerequisite to major graduate work is the completion of an undergraduate curriculum essentially equivalent to the curriculum in liberal arts and sciences at this institution including at least a year of calculus.

The degree master of science may be earned on either a thesis or nonthesis basis. The nonthesis option requires the completion of at least 34 credits of acceptable graduate work, including the completion of a creative component and satisfactory performance on a written examination. The thesis option requires the completion of 34 credits of acceptable graduate work, including the completion of a thesis and satisfactory performance on a written examination.

The department encourages students to prepare themselves in foreign languages and in computer languages, but specific requirements for the degrees master of science and doctor of philosophy are at the discretion of the student's advisory committee.

The department participates in the interdisciplinary program in business administrative sciences and in the interdepartmental major in genetics.

Courses open for nonmajor graduate credit: 328, 330, 361, 401, 402, 403, 404, 406, 407, 415, 421, 432, 447, 451, 479, 480, 493, 495, 496.

Courses Primarily for Undergraduate Students

Stat 100. Orientation in Statistics. (1-0) Cr. R. F. Opportunities, challenges, and the scope of the curriculum in statistics. For students planning or considering a career in this area.

Stat 101. Principles of Statistics. (3-2) Cr. 4. F.S.SS. *Prereq:* 1 1/2 years of high school algebra. Statistical concepts in modern society; descriptive statistics and graphical displays of data; the normal distribution; data collection; elementary probability; elements of statistical inference; estimation and hypothesis testing; linear regression and correlation; contingency tables. Credit for only one of the following courses may be applied toward graduation: 101, 104, 105, 226.

Stat 104. Introduction to Statistics. (2-2) Cr. 3. F.S.SS. *Prereq:* 1 1/2 years of high school algebra. Statistical concepts and their use in science; collect-

ing, organizing and drawing conclusions from data; elementary probability; binomial and normal distributions; regression; estimation and hypothesis testing. For students in the agricultural and biological sciences. Credit for only one of the following courses may be applied toward graduation: 101, 104, 105, 226.

Stat 105. Introduction to Statistics for Engineers. (3-0) Cr. 3. F.S. *Prereq: Math 165 (or 165H).* Statistical concepts with emphasis on engineering applications. Data collection; descriptive statistics; probability distributions and their properties; elements of statistical inference; regression; statistical quality control charts; use of statistical software; team project involving data collection, description and analysis. Credit for only one of the following courses may be applied toward graduation: 101, 104, 105, 226. Credit for both 105 and 305 may not be applied for graduation.

Stat 226. Introduction to Business Statistics I. (3-0) Cr. 3. F.S.SS. *Prereq: Math 150 or 165.* Obtaining, presenting, and organizing statistical data; measures of location and dispersion; the Normal distribution; sampling and sampling distributions; estimation and confidence intervals; interference for simple linear regression analysis; use of computers to visualize and analyze data. Credit for only one of the following courses may be applied toward graduation: 101, 104, 105, 226.

Stat 231. Probability and Statistical Inference for Engineers. (4-0) Cr. 4. F.S. *Prereq: Credit or enrollment in Math 265.* Emphasis on engineering applications. Basic probability; random variables and probability distributions; joint and sampling distributions; ~~propagation of error.~~ Descriptive statistics; confidence intervals; hypothesis testing; simple linear regression; multiple linear regression; one way analysis of variance; use of statistical software.

Stat 305. Engineering Statistics. (3-0) Cr. 3. F.S.SS. *Prereq: Math 165 (or 165H).* Statistics for engineering problem solving. Principles of engineering data collection; descriptive statistics; elementary probability distributions; principles of experimentation; confidence intervals and significance tests; one-, two-, and multi-sample studies; regression analysis; use of statistical software; team project involving engineering experimentation and data analysis. Credit for both 105 and 305 may not be applied for graduation.

Stat 322. Probabilistic Methods for Electrical Engineers. (Same as E E 322.) (3-0) Cr. 3. F.S. *Prereq: E E 224.* Introduction to probability with applications to electrical engineering. Sets and events, probability, reliability of systems. Discrete and continuous random variables, associated probability modes, extensions to multivariate random vectors. Expectation, moments,

correlation, functions of random variables. Random processes.

Stat 326. Introduction to Business Statistics II. (2-2) Cr. 3. F.S. *Prereq:* 226. Multiple regression analysis; regression diagnostics; model building; applications in analysis of variance and time series; **statistical** process control methods; use of computers to visualize and analyze data.

Stat 328. Applied Business Statistics. (2-2) Cr. 3. F.S. *Prereq:* 326, primarily for MBA students. Application of statistical methods to problems in business and economics; review of multiple regression; residual analysis; model building; analysis of variance; introduction to experimental design concepts; time series analysis and forecasting. Nonmajor graduate credit.

Stat 330. Probability and Statistics for Computer Science. (3-0) Cr. 3. F.S. *Prereq:* Math 166. Topics from probability and statistics applicable to computer science. Basic probability; Random variables and their distributions; Elementary probabilistic simulation; Queuing models; Basic statistical inference; Introduction to regression. Nonmajor graduate credit.

Stat 341. Introduction to the Theory of Probability and Statistics I. (Same as Math 341.) (3-0) Cr. 3. F.S. *Prereq:* Math 265 (or 265H). Probability; distribution functions and their properties; classical discrete and continuous distribution functions; moment generating functions, multivariate probability distributions and their properties. Credit for both 341 and 447 may not be applied toward graduation.

Stat 342. Introduction to the Theory of Probability and Statistics II. (Same as Math 342.) (3-0) Cr. 3. S. *Prereq:* 341, Math 307 or 317. **Sampling distributions;** confidence intervals; theory of estimation and tests of hypotheses; linear model theory; ~~enumerative data.~~

Stat 361. Statistical Quality Assurance. (Same as I E 361.) See *Industrial Engineering*. Nonmajor graduate credit.

Stat 398. Cooperative Education. Cr. R. F.S.SS. *Prereq:* Permission of department chair. Off-campus work periods for undergraduate students in a field of statistics.

Stat 401. Statistical Methods for Research Workers. (3-2) Cr. 4. F.S.SS. *Prereq:* 101 or 104 or 105 or 226. Graduate students without an equivalent course should contact the department. Methods of analyzing and interpreting experimental and survey data. Statistical concepts and models; estimation; hypothesis tests with continuous and discrete data; simple and multiple linear regression and correlation; introduction to analysis of **variance.** Nonmajor graduate credit.

Stat 401I. Statistical Methods for Field Biologists. (Same as Ia LL 401I.) See *Iowa Lakeside Laboratory*.

Stat 402. Statistical Design and the Analysis of Experiments. (3-0) Cr. 3. F.S. *Prereq:* 401. The role of statistics in research and the principles of experimental design. Experimental units, randomization, replication, blocking, subdividing and repeatedly measuring experimental units; factorial treatment designs and confounding; extensions of the analysis of variance to cover general crossed and nested classifications and models that include both classificatory and continuous factors. Nonmajor graduate credit.

Stat 403. Distribution Free and Nonparametric Statistical Methods. (3-0) Cr. 3. Alt. F., offered 2003. *Prereq:* 231 or 328 or 401. Statistical inference for non-normally distributed data; analysis of rank data; efficiency of distribution free procedures and robustness of comparable normal theory procedures; nonparametric modeling. Nonmajor graduate credit.

Stat 404. Regression for Social and Behavioral Research. (2-2) Cr. 3. F. *Prereq:* 401. Lorenz, Roberts. Applications of generalized linear regression models to social science data. Assumptions of regression; diagnostics and transformations; analysis of variance and covariance; path analysis. Nonmajor graduate credit.

Stat 406. Statistical Methods for Spatial Data. (Dual-listed with 506.) (3-0) Cr. 3. Alt. S., offered 2004. *Prereq:* Six hours of statistics at the 400-level. The analysis of spatial data; geostatistical methods and spatial prediction; discrete index random fields and Markov random field models; models for spatial point processes. Emphasis on application and practical use of spatial statistical analysis. Nonmajor graduate credit.

Stat 407. Methods of Multivariate Analysis. (2-2) Cr. 3. F. *Prereq:* 401, knowledge of matrix algebra. Carriquiry, Cook. Techniques for analyzing multivariate data including comparing group mean vectors using Hotelling's T^2 , multivariate analysis of variance, reducing variable dimension with principal components, grouping/classifying observations with cluster analysis and discriminant analysis. Imputation of missing multivariate observations. Nonmajor graduate credit.

Stat 415. Advanced Statistical Methods for Research Workers. (2-2) Cr. 3. Alt. S., offered 2005. *Prereq:* 401. Advanced statistical methods using modern computer methods for modeling and analyzing data. Examples from a wide variety of scientific and engineering disciplines. Nonmajor graduate credit.

Stat 421. Survey Sampling Techniques. (2-2) Cr. 3. S. *Prereq:* 231 or 328 or 401. Methods of designing and analyzing survey investigations; simple random, stratified, and multistage sampling designs; methods

of estimation including ratio and regression; construction and use of sample frames. Nonmajor graduate credit.

Stat 432. Applied Probability Models. (3-0) Cr. 3. F. *Prereq: 231 or 341 or 447.* Probabilistic models in biological, engineering and the physical sciences. Markov chains; Poisson, birth-and-death, renewal, branching and queing processes; applications to bioinformatics and other quantitative problems. Nonmajor graduate credit.

Stat 447. Statistical Theory for Research Workers. (4-0) Cr. 4. F.S.SS. *Prereq: Math 151 and permission of instructor, or Math 265.* Primarily for graduate students not majoring in statistics. Emphasis on aspects of the theory underlying statistical methods. Probability, population distributions and their properties, sampling distributions, point and interval estimation, tests of hypotheses, simple regression. Credit for both 341 and 447 may not be applied toward graduation. Nonmajor graduate credit

Stat 451. Applied Time Series. (3-0) Cr. 3. S. *Prereq: 231 or 328 or 401.* Meeker. Methods for analyzing data collected over time; review of multiple regression analysis. Elementary forecasting methods: moving averages and exponential smoothing. Autoregressive-moving average (Box-Jenkins) models: identification, estimation, diagnostic checking, and forecasting. Transfer function models and intervention analysis. Nonmajor graduate credit.

Stat 479. Computer Processing of Statistical Data. (3-0) Cr. 3. F. *Prereq: 401.* Marasinghe. Structure, content and programming aspects of a modern statistical package. Advanced techniques in the use of a statistical software system for data analysis. Introduction to graphical methods in statistics and a macro programming language. Currently SAS is the software system used. Nonmajor graduate credit.

Stat 480. Statistical Computing Applications. (3-0) Cr. 3. S. *Prereq: 231 or 328 or 401.* Modern statistical computing. Data management; spread sheets, verifying data accuracy, transferring data between systems. Data and graphical analysis with microcomputer statistical software packages. Macro programming. Algorithmic programming concepts and applications. Simulation. ~~Interface with the World Wide Web.~~ Software reliability. Nonmajor graduate credit.

Stat 490. Independent Study. Cr. var. *Prereq: 10 credits in statistics.* No more than 9 credits in Stat 490 may be counted toward graduation. H: Honors.

Stat 493. Workshop in Statistics. (1-0 or 2-0) Cr. 1 or 2. Off-campus, offered as demand warrants. *Prereq: 101 or 104 or 226.* Planning, executing, and interpreting experiments by understanding experimental design

and utilizing the statistical concepts of linear models.

Designed for master of agriculture program only.
Nonmajor graduate credit.

Stat 495. Applied Statistics for Industry I. (3-0)

Cr. 3. Alt. F., offered 2004. *Prereq:* 101 or 104 or 105 or 226; *Math 166 (or 166H)*. Graduate students without an equivalent course should consult the department. Statistical thinking applied to industrial processes. Assessing, monitoring and improving processes using statistical methods. Analytic/enumerative studies; graphical displays of data; process monitoring; control charts; capability analysis. Nonmajor graduate credit.

Stat 496. Applied Statistics for Industry II. (3-0)

Cr. 3. Alt. S., offered 2005. *Prereq:* 495. Statistical design and analysis of industrial experiments. Concepts of control, randomization and replication. Simple and multiple regression; factorial and fractional factorial experiments; reliability; analysis of lifetime data. Nonmajor graduate credit.

Courses Primarily for Graduate Students, Open to Qualified Undergraduate Students

Stat 500. Statistical Methods. (3-2) Cr. 4. F. *Prereq:* 101. Introduction to methods for analyzing data from experiments and surveys. Graphical data summaries.

Comparison of groups using t-tests, analysis of variance, and nonparametric analogs. Uses of randomization, blocking, factorial designs, and nested units in experiments. Correlation and regression models, model selection and assessment, effects of collinearity. Introduction to SAS statistical software.

Stat 501. Multivariate Statistical Methods. (3-0)

Cr. 3. S. *Prereq:* 500 or 402; 447 or 542; *knowledge of matrix algebra*. Statistical methods for analyzing and displaying multivariate data: dynamic graphics, principal components, factor analysis, canonical correlations, cluster analysis, classification methods, Hotelling's T^2 , multivariate analysis of variance. Statistical software: SAS, S-Plus and GGobi.

Stat 503. Exploratory Methods and Data Mining.

(2-2) Cr. 3. Alt. S., offered 2005. *Prereq:* 401, 341 or 447. Approaches to finding the unexpected in data; pattern recognition, classification, association rules, graphical methods, classical and computer-intensive statistical techniques, and problem solving. Emphasis is on data-centered, non-inferential statistics for large or high-dimensional data, topical problems, and building report writing skills.

Stat 505. Environmental Statistics. (2-2) Cr. 3. Alt.

S., offered 2004. *Prereq:* 341 or 447; 401. Basic ideas of statistical modeling for environmental applications; causation versus association; ecotoxicology; limits of

detection; spatial statistics; geostatistics, kriging, spatial sampling; hierarchical modeling, Bayesian methodology.

Stat 506. Statistical Methods for Spatial Data. (Dual listed with 406.) (3-0) Cr. 3. Alt. S., offered 2004.

Prereq: 447 or 542. The analysis of spatial data; geostatistical methods and spatial prediction; discrete index random fields and Markov random field models; models for spatial point processes.

Stat 511. Statistical Methods. (3-0) Cr. 3. S. *Prereq:* 500 or 402 or 404; 447 or 542 and current enrollment in 543; knowledge of matrix algebra. Introduction to the general theory of linear models, least squares and maximum likelihood estimation, hypothesis testing, analysis of unbalanced designs, models with both fixed and random factors. Introduction to non-linear and generalized linear models, bootstrap estimation, local smoothing methods. Requires use of S-Plus statistical software.

Stat 512. Design of Experiments. (3-0) Cr. 3. F. *Prereq:* 511. Basic ideas of experimental design and analysis; completely randomized, randomized complete block, and Latin Square designs; randomization analysis; factorial experiments, confounding, fractional replication; split-plot and incomplete block designs; crossover designs.

Stat 513. Response Surface Methodology. (3-0) Cr. 3. Alt. S., offered 2004. *Prereq:* 402 or 512, knowledge of elementary matrix theory and matrix formulation of regression. Morris. Analysis techniques for locating optimum and near-optimum operating conditions: standard experimental designs for first- and second-order response surface models; design performance criteria; use of data transformations; mixture experiments; optimization for multiple-response problems. Requires use of statistical software with matrix functions.

Stat 515. Theory and Applications of Nonlinear Models. (3-0) Cr. 3. F. *Prereq:* 447 or 543, 511. Kaiser. Construction of nonlinear statistical models; random and systematic model components, review of likelihood-based inferences. Iterative algorithms for maximum likelihood estimation. Nonlinear regression models using additive error with nonconstant variance, transform both sides models, generalized linear models and their extensions. Introduction to compartment models, growth curves and pharmaco-kinetic models. Basic random parameter models, beta-binomial and gamma-Poisson mixtures. Requires use of instructor-supplied and student-written S-plus functions.

Stat 521. Theory and Applications of Sample Surveys. (3-0) Cr. 3. S. *Prereq:* 401; 447 or 542. Maiti, Opsomer. Practical aspects and basic theory of design and estimation in sample surveys for finite

populations. Simple random, systematic, stratified, cluster multistage and unequal-probability sampling. Horvitz-Thompson estimation of totals and functions of totals: means, proportions, regression coefficients. Linearization technique for variance estimation. Model-assisted ratio and regression estimation. Two-phase sampling and sampling on two occasions. Non-response effects. Imputation.

Stat 531. Quality Control and Engineering Statistics. (Same as I E 531.) (3-0) Cr. 3., Alt. S., offered 2005. Prereq: 401; 342 or 447. Vardeman. Statistical methods and theory applicable to problems of industrial process monitoring and improvement. Statistical issues in industrial measurement; Shewhart, CUSUM, and other control charts; feedback control; process characterization studies; estimation of product and process characteristics; acceptance sampling, continuous sampling and sequential sampling; economic and decision theoretic arguments in industrial statistics.

Stat 533. Reliability. (Same as I E 533.) (3-0) Cr. 3. Alt. S., offered 2004. Prereq: 342 or 432 or 447. Meeker. Probabilistic modeling and inference in reliability; analysis of systems; Bayesian aspects; product limit estimator, probability plotting, maximum likelihood estimation for censored data, accelerated failure time and proportional hazards regression models with applications to accelerated life testing; repairable system data; planning studies to obtain reliability data.

Stat 534. Ecological Statistics. (3-0) Cr. 3. Alt. F., offered 2003. Prereq: 447 or 542. Dixon. Statistical methods for analysis of data from ecological field studies. Estimation of abundance from mark-recapture data. Deterministic and stochastic matrix models of population trends. Estimation of species richness and diversity. Ordination and analysis of complex multivariate data. Statistical methods discussed will include randomization and permutation tests, spatial point processes, bootstrap estimation of standard error, partial likelihood and Empirical Bayes methods.

Stat 536. Genetic Statistics. (Same as Gen 536.) (3-0) Cr. 3. Alt. F., offered 2004. Prereq: 401, 447; Gen 320 or Biol 301. Probability applied to genetic systems; random mating; selection, mutation and migration; theory of inbreeding; effects of finite population size; basic concepts in quantitative genetics; prediction of progress from artificial selection.

Stat 537. Statistics for Molecular Genetics. (Same as Gen 537.) (3-0) Cr. 3. Alt. S., offered 2005. Prereq: 536. Sampling designs and experimental designs to obtain information from markers; detecting major genes; linkage analysis and segregation analysis; finding alignments and similarities between DNA sequences; constructing phylogenetic trees.

Stat 542. Theory of Probability and Statistics I. (4-0)

Cr. 4. F. *Prereq:* 341; Math 414 or 465. Sample spaces, probability, conditional probability; Random variables, univariate distributions, expectation, moment generating functions; Common theoretical distributions; Joint distributions, conditional distributions and independence, covariance; Probability laws and transformations; Introduction to the Multivariate Normal distribution; Sampling distributions, order statistics; Convergence concepts, the central limit theorem and delta method; Basics of stochastic simulation.

Stat 543. Theory of Probability and Statistics II. (3-0)

Cr. 3. S. *Prereq:* 542. Point estimation including method of moments, maximum likelihood estimation, exponential family, Bayes estimators, Loss function and Bayesian optimality, unbiasedness, sufficiency, completeness, Basu's theorem; Interval estimation including confidence intervals, prediction intervals, Bayesian interval estimation; Hypothesis testing including Neyman-Pearson Lemma, uniformly most powerful tests, likelihood ratio tests; Bayesian tests; Nonparametric methods, bootstrap.

Stat 544. Bayesian Statistics. (3-0) Cr. 3. S. *Prereq:*

543. Specification of probability models; subjective, conjugate, and noninformative prior distributions; hierarchical models; analytical and computational techniques for obtaining posterior distributions; model checking, model selection, diagnostics; comparison of Bayesian and traditional methods.

Stat 546. Theory of Nonparametric and Asymptotic

Methods. (3-0) Cr. 3. Alt. S., offered 2005. *Prereq:*

542. Introduction to nonparametric problems; tests based upon sample distribution functions, rank tests for location, scale and independence; local properties of rank tests; convergence of a sequence of random variables; limit theorems; asymptotic distributions of sample quantiles, U-statistics, rank statistics, chi-square and other goodness of fit test statistics; asymptotic efficiency of tests.

Stat 551. Time Series Analysis. (3-0) Cr. 3. F. *Prereq:*

447 or 542. ~~Huang~~. Stationary and non-stationary time series; covariance and spectral properties of stationary time series; autoregressive moving average processes; best linear prediction; ~~state space models and Kalman recursions~~; estimation techniques, model building and diagnostics.

Stat 554. Introduction to Stochastic Processes.

(Same as Math 554.) See *Mathematics*.

Stat 555. Theory of Stochastic Processes. (Same as

Math 555.) See *Mathematics*.

Stat 557. Statistical Methods for Counts and

Proportions. (3-0) Cr. 3. Alt. F., offered 2004. *Prereq:* 500 or 401; 543 or 447. ~~Kochler~~. Statistical methods for analyzing simple random samples when outcomes are counts or proportions; measures of association

and relative risk, chi-squared tests, loglinear models, logistic regression and other generalized linear models, extensions to longitudinal studies and complex designs, models with fixed and random effects. Use of statistical software: SAS or S-Plus.

Stat 565. Methods in Biostatistics. (Same as Tox 565.) (3-0) Cr. 3. Alt. F., offered 2003. *Prereq:* 500; 543 or 447. Statistical methods useful for biostatistical problems. Topics include analysis of observational studies and randomized clinical trials, techniques in the analysis of survival and longitudinal data, approaches to handling missing data, and meta-analysis. Examples will come from recent studies in cancer, AIDS, heart disease and psychiatry and from studies to evaluate health care in the U.S. (health services research).

Stat 579. Orientation to Software Systems for Statistical Computing. (1-0) Cr. 1. F. *Prereq:* Graduate classification in statistics. Kennedy, Marasinghe. Orientation to scientific and statistical software available on campus. Offered on a satisfactory-fail grading basis only.

Stat 580. Computational Methods in Statistics. (3-0) Cr. 3. S. *Prereq:* 500, 542. Marasinghe. Linear and nonlinear least squares and regression computations, computations associated with maximum likelihood estimation problems, applications of Monte Carlo methods in statistics research, computer intensive applications including the bootstrap, evaluation of multiple integrals, EM algorithm, etc. Assignments will include applications of these methods using the S-Plus programming language.

Stat 581. Advanced Statistical Computing. (3-0) Cr. 3. Alt. F., offered 2004. *Prereq:* 511, 580 and programming in a scientific language. Marasinghe, Kennedy. Numerical computations and algorithms with applications in statistics. These include discussions on random number generation, solution of nonlinear equations, optimization methods, numerical linear algebra, numerical integration and approximation methods.

Stat 590. Special Topics. Cr. var.

- A. Theory
- B. Methods
- C. Design of Experiments
- D. Design of Surveys

Stat 598. Cooperative Education. Cr. R. F.S.SS. *Prereq:* Permission of the department chair. Off-campus work periods for graduate students in a field of statistics.

Stat 599. Creative Component.

Courses for Graduate Students

Stat 601. Advanced Statistical Methods. (4-0) Cr. 4. F. *Prereq:* 511. This course is designed to provide

students with computational and simulation skills needed to address current and recent developments in statistical modelling and applications. Topics may include resampling procedures, Markov Chain Monte Carlo, procedures for solving estimating equations, nonparametric procedures, analysis of large complex data sets. Assignments are designed to develop problem solving and communication skills and will include application of R and other software.

Stat 606. Advanced Spatial Statistics. (3-0) Cr. 3. Alt. S., offered 2005. *Prereq: 506, 642.* General formulation of spatial models; construction of nonstationary covariance functions; conditional and simultaneous model specification; ~~hierarchical spatial models and Bayesian analysis~~; random measures and point processes; spatio-temporal models.

Stat 611. Theory and Applications of Linear Models. (3-0) Cr. 3. F. *Prereq: 500 or 402 or 404, 542 or 447, a course in matrix algebra.* Wu. Matrix preliminaries, estimability, theory of least squares and of best linear unbiased estimation, analysis of variance and covariance, distribution of quadratic forms, extension of theory to mixed and random models, inference for variance components.

Stat 612. Advanced Design of Experiments. (3-0) Cr. 3. Alt. S., offered 2005. *Prereq: 512.* Advanced topics of current interest in design of experiments, which may include design optimality criteria; theoretical and computational aspects of identifying optimal and efficient designs; design construction tools; fractional factorial designs; theory of approximate designs and the equivalence theorem; crossover designs with applications.

Stat 621. Advanced Theory of Survey Sampling. (3-0) Cr. 3. Alt. F., offered 2004. *Prereq: 521.* Advanced topics of current interest in the design of surveys and analysis of survey data, including: asymptotic theory for design and model-based estimators, use of auxiliary information in estimation, variance estimation techniques, small area estimation, non-response modeling and imputation.

Stat 642. Advanced Probability Theory. (Same as Math 642.) (4-0) Cr. 4. F. *Prereq: 542.* ~~Athreya, Lahiri, Yang.~~ Probability spaces; Kolmogorov's existence theorem for stochastic processes; expectation; Jensen's inequality and applications; Borel-Cantelli lemmas; Weak and strong laws of large numbers; ~~convergence of moments; weak convergence of probability distributions; characteristic functions; continuity theorem; Lindeberg-Feller central limit theorem and its ramifications; conditional expectation and probability; discrete time martingales, discrete parameter Markov chains, Brownian motion.~~

Stat 643. Advanced Theory of Statistical Inference. (4-0) Cr. 4. S. *Prereq: 543, 642.* ~~Lahiri, Vardeman.~~

Sufficiency, completeness; Elements of decision theory; ~~Bayesian paradigm of inference and theory of Markov Chain Monte Carlo; Invariance;~~ Neyman-Pearson theory of testing hypotheses. Uniformly most powerful tests, introduction to unbiased tests, likelihood ratio tests, ~~Wald's tests, Rao's tests;~~ Asymptotic theory of maximum likelihood estimation and likelihood ratio tests; Asymptotic efficiency; Resampling methods.

Stat 647. Multivariate Analysis. (3-0) Cr. 3. **F.** *Prereq:* 543, knowledge of matrix algebra. ~~Amemiya.~~ Multivariate normal distribution, Wishart distribution, multiple, partial, and canonical correlations, inference for mean vector, multivariate regression, principal components, discriminant analysis, factor analysis, covariance structure analysis, latent variable modeling.

Stat 648. Seminar on Theory of Statistics and Probability. Cr. var. Alt. **S.**, offered 2004. *Prereq:* 643.

Stat 651. Time Series. (3-0) Cr. 3. Alt. **S.**, offered 2004. *Prereq:* 551, 642. Covariance and spectral representation of time series. Stationary and nonstationary autoregressive models. Fourier and periodogram analyses. Stochastic difference equations. Estimation and distribution theory.

Stat 690. Advanced Special Topics. Cr. Var. *Prereq:* Permission of instructor.

- A. Theory
- B. Methods
- C. Design of Experiments
- D. Design of Surveys**
- E. Statistical Computing
- F. Graphics

Stat 699. Research.